Two-proton correlations from 158 AGeV Pb+Pb central collisions [1]

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Nuclear matter at high energy density has been extensively studied through high energy heavy ion collisions. The spatial baryon density plays an important role in the dynamical evolution of these collisions. An essential ingredient for establishing the spatial baryon density is the space-time extent of the baryon source at freezeout. This space-time extent can be inferred from two-proton correlation functions [2]. We report here a measurement of two-proton correlation function in the midrapidity region from Pb+Pb central collisions at 158 AGeV by the NA49 collaboration at the CERN SPS.

The measured correlation function was corrected for the contamination from weak decay protons and the finite momentum resolution. The corrected correlation function is plotted in Fig. 1 as filled points. The main peak at $q_{inv} = 20$ MeV/c is due to two-proton correlation. An unexpected structure at 70 MeV/c is observed. This structure is the subject of another report [3].

In order to assess the proton freeze-out conditions, we compare the measured two-proton correlation function to theoretical calculations. Given the proton phase space density distribution, the two-proton correlation function can be calculated by the Koonin-Pratt Formalism [2, 4]. We use two types of proton freeze-out distributions: (1) Gaussian sources, and (2) protons generated for Pb+Pb central collisions at 158 AGeV by two microscopic transport models: RQMD and VENUS. The calculated correlation functions are shown in Fig. 1 together with the data.

By fitting the data to Gaussian sources, we extract an effective Gaussian source size: $\sigma = 3.85 \pm 0.15(\text{stat.})^{+0.60}_{-0.25}(\text{syst.})$ fm. The systematic errors are due to the uncertainty in weak decay contamination and the unexpected structure observed on the tail of the correlation function. Both the RQMD and the VENUS model are
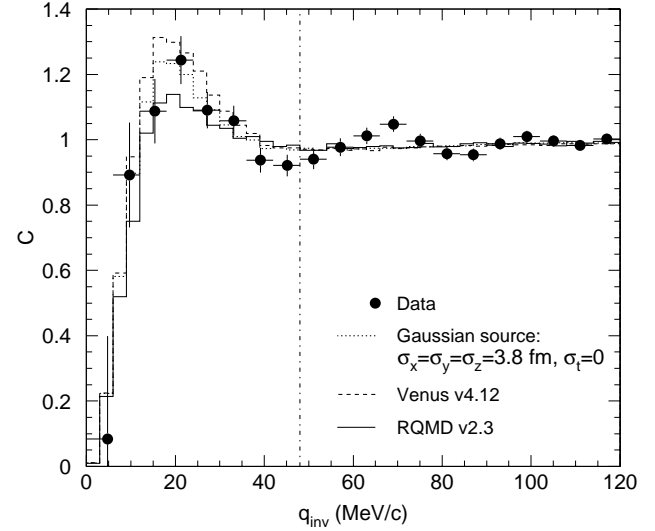

Figure 1: The two-proton correlation function after corrections for the 44% contamination due to weak decay protons and the finite momentum resolution (points), compared to calculations for a Gaussian source (dotted), and for freeze-out protons from RQMD (solid) and VENUS (dashed). The errors shown on the data points are statistical only.

consistent with the data within the error in the correlation peak region.

References

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